Methodical Development of a Lightweight Car Body for a High-Speed Train

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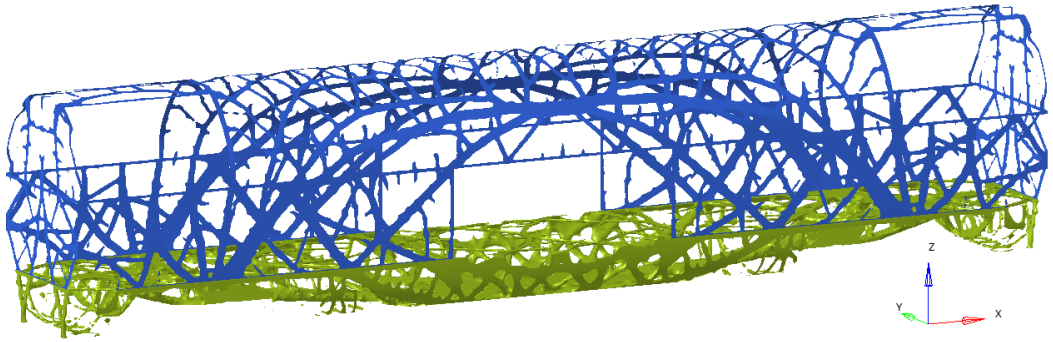
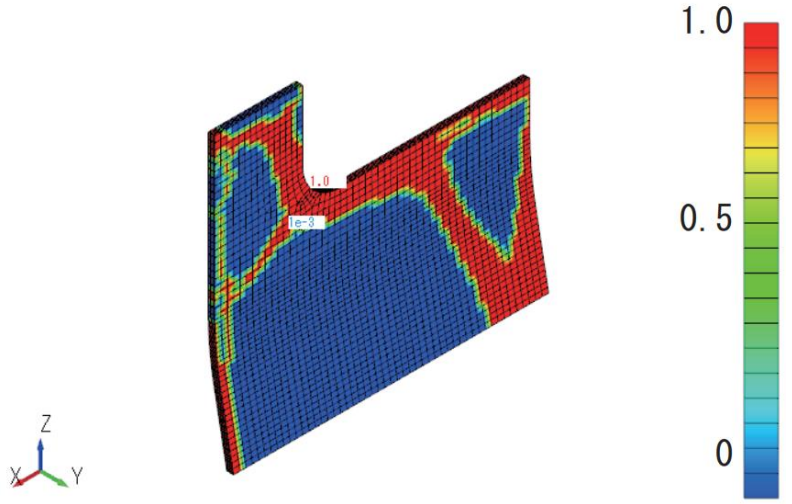
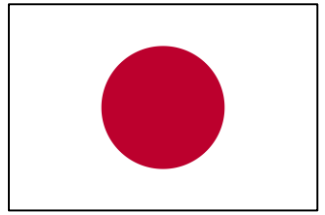
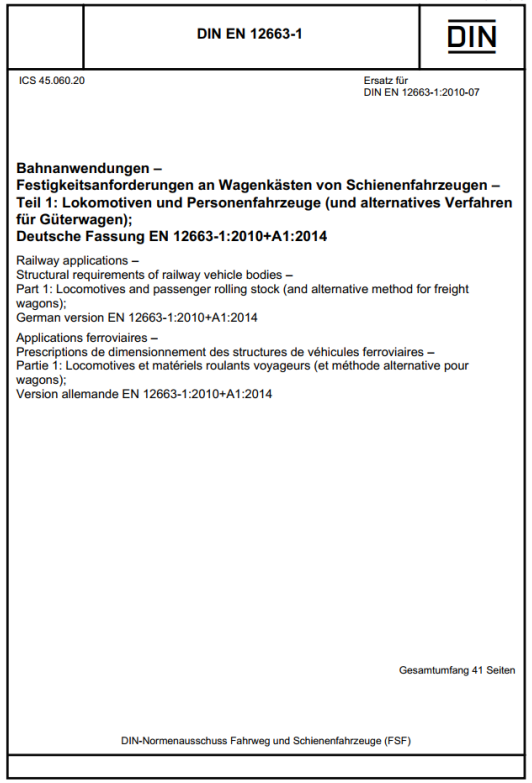
Lightweight Design Activities







Standards



DIN EN 12663-1

DIN

ICS 45.060.20

Ersatz für
DIN EN 12663-1:2010-07

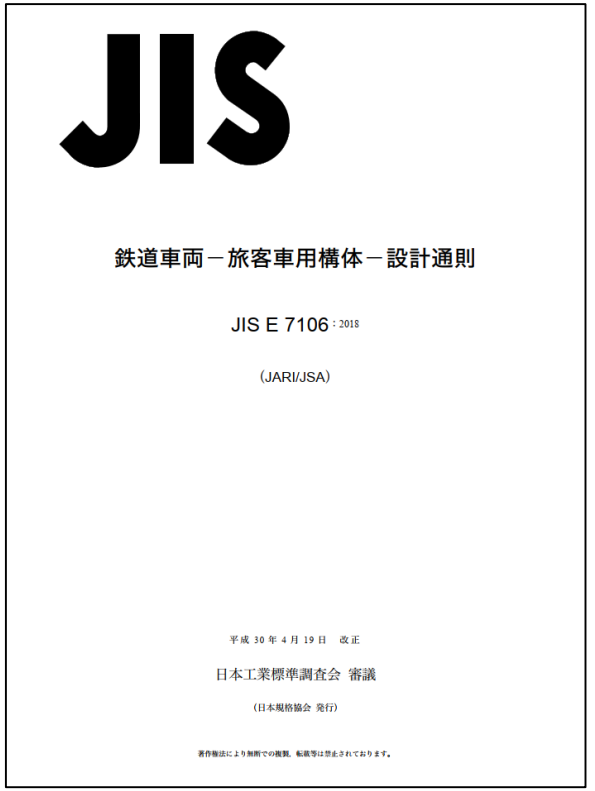
Bahnanwendungen –
Festigkeitsanforderungen an Wagenkästen von Schienenfahrzeugen –
Teil 1: Lokomotiven und Personenfahrzeuge (und alternatives Verfahren für Güterwagen);
Deutsche Fassung EN 12663-1:2010+A1:2014

Railway applications –
Structural requirements of railway vehicle bodies –
Part 1: Locomotives and passenger rolling stock (and alternative method for freight wagons);
German version EN 12663-1:2010+A1:2014

Applications ferroviaires –
Prescriptions de dimensionnement des structures de véhicules ferroviaires –
Partie 1: Locomotives et matériels roulants voyageurs (et méthode alternative pour wagons);
Version allemande EN 12663-1:2010+A1:2014

Gesamtumfang 41 Seiten

DIN-Normenausschuss Fahrweg und Schienenfahrzeuge (FSF)



JIS

鉄道車両－旅客車用構体－設計通則

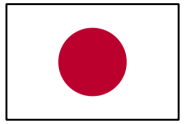
JIS E 7106：2018

(JARI/JSA)

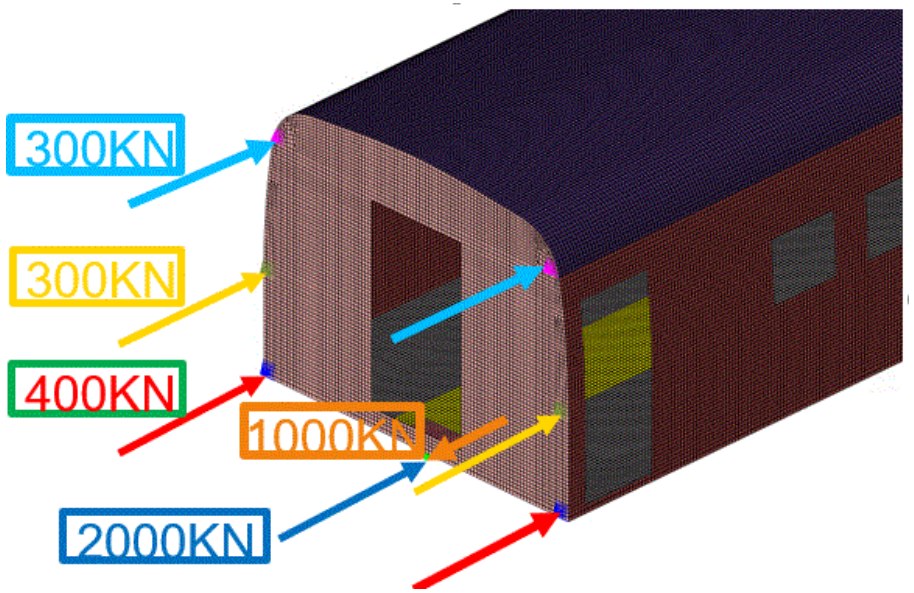
平成 30 年 4 月 19 日　改正

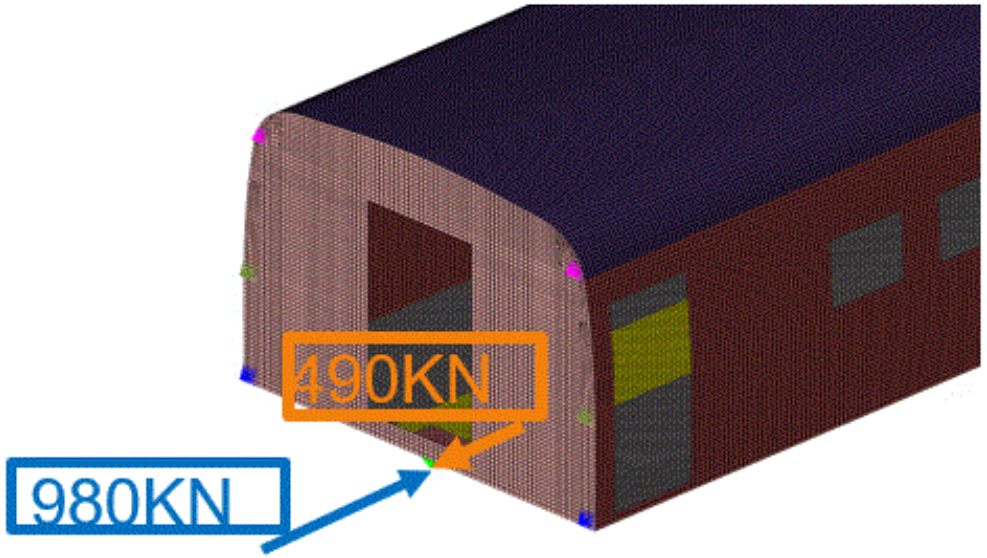
日本工業標準調査会 審議

(日本規格協会 発行)



Longitudinal Load Cases

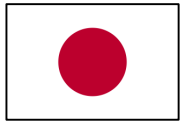




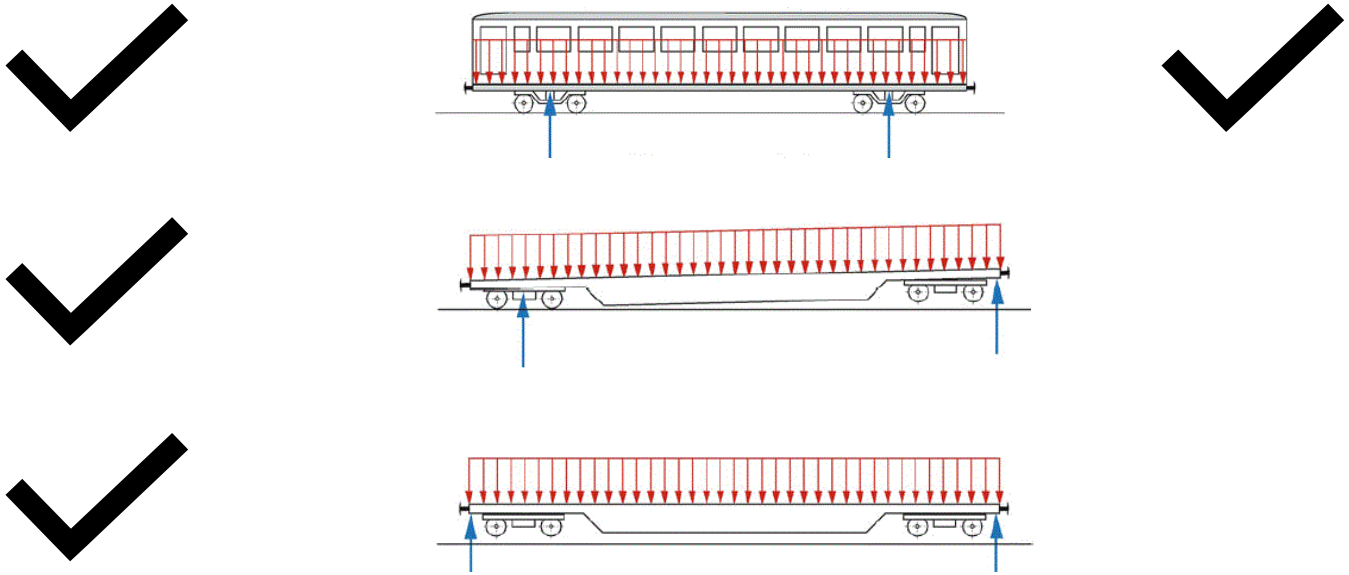
Payload

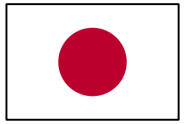
10kg 70kg

5kg 55kg

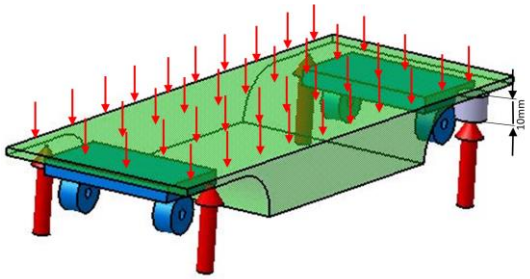


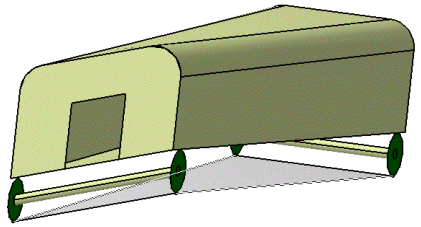
Vertical Load Cases



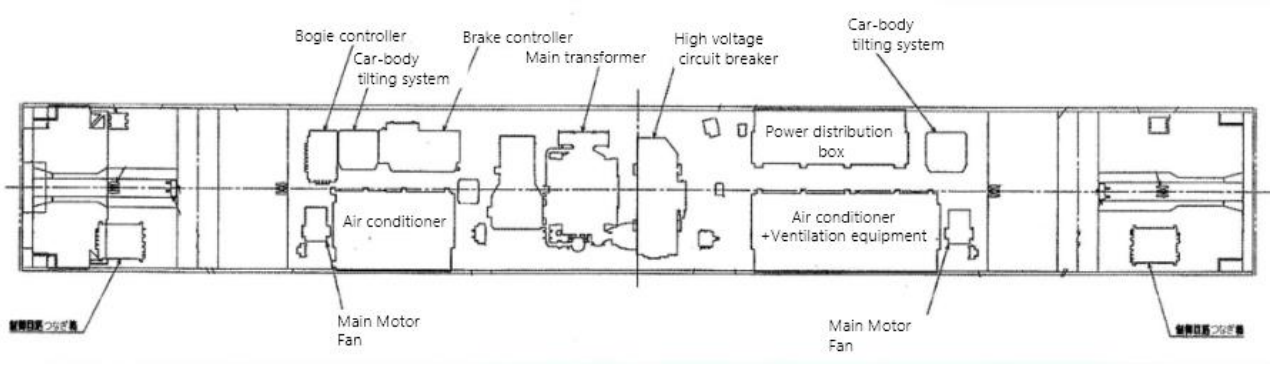


Torsional Load Cases





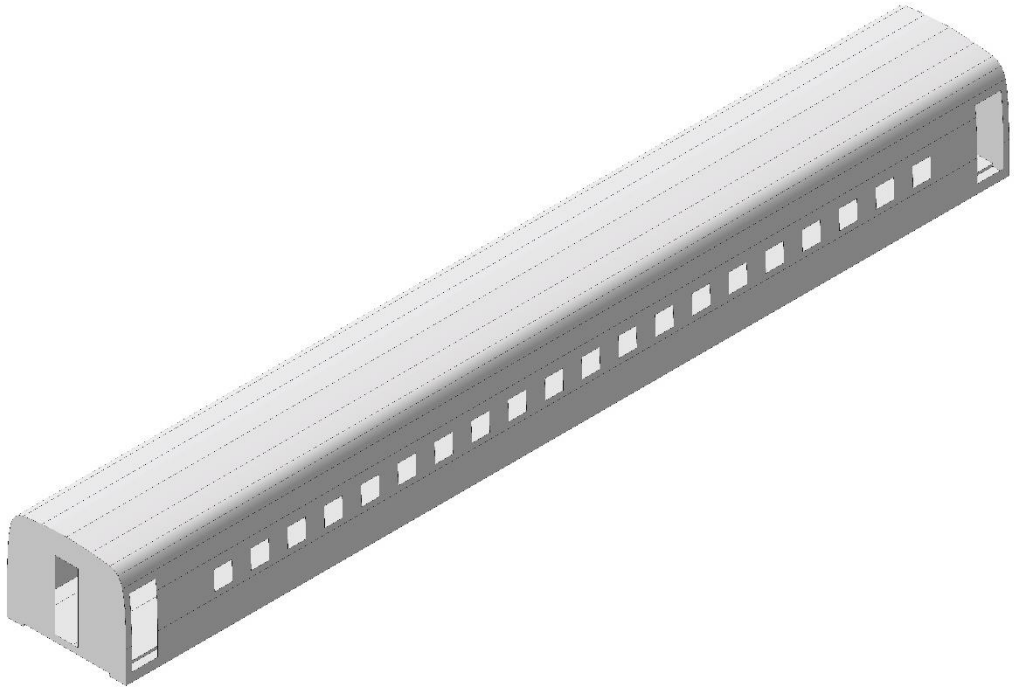
Equipment



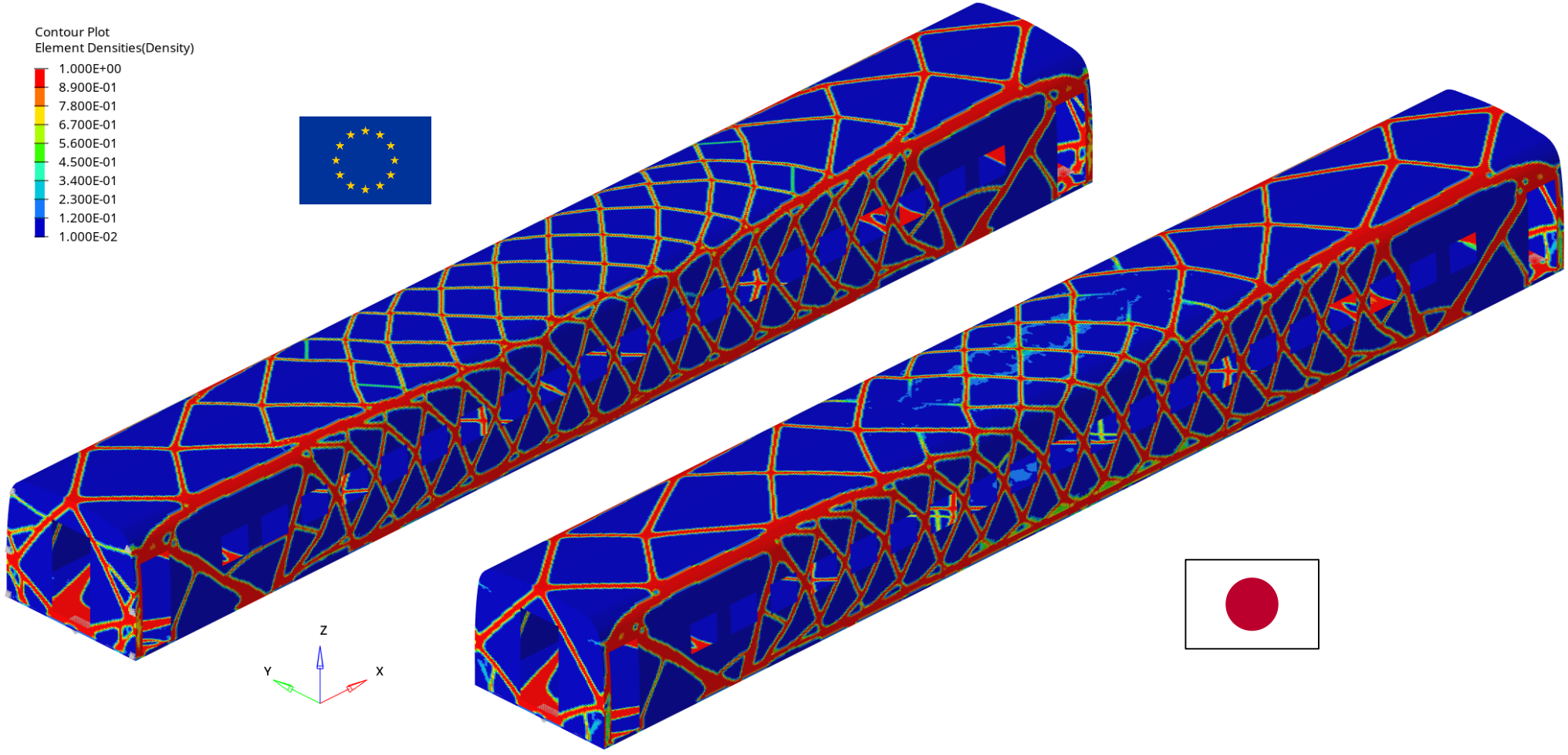
Equipment	Mass
Car-body tilting System	79kg x 2
Air conditioner	800kg
Ventilation Equipment	220kg
High voltage circuit braker	525kg
Main transfomer	2840kg
Bogie controller	110kg

Generic Car Body

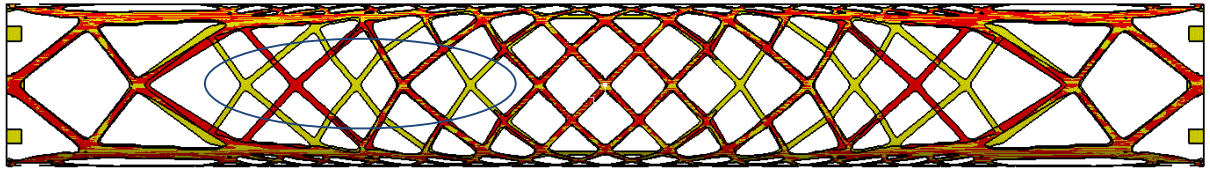
Basic Dimension	Length
Length of car body	24.5 m
Length for seats	21.5 m
Width of the car body	3.3 m
Distance between pivots	17.5 m
Length of the cut out in the skirt for bogies	3.9 m
Length of the entrance area (doors)	1.2 m & 1.8 m
Width of the floor between seats	0.57 m
Length for one seat row	1.05 m



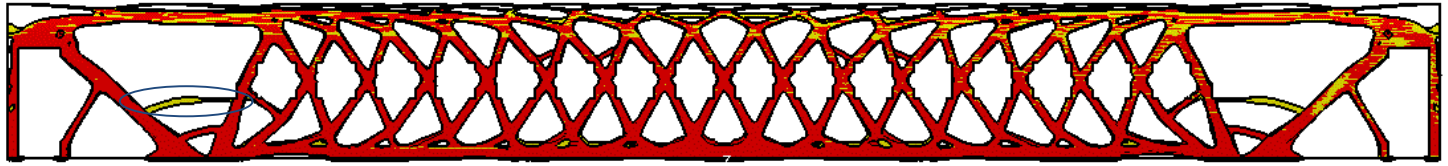
Topology Optimization



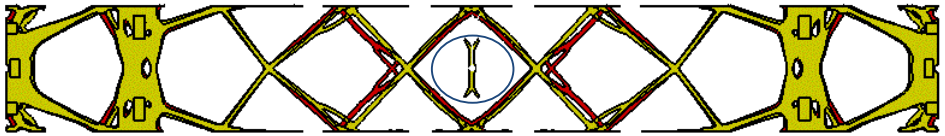
Comparison



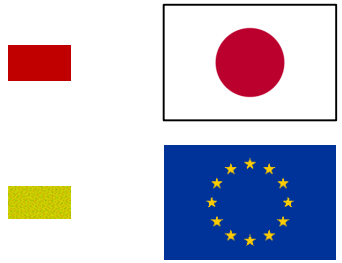
Top View



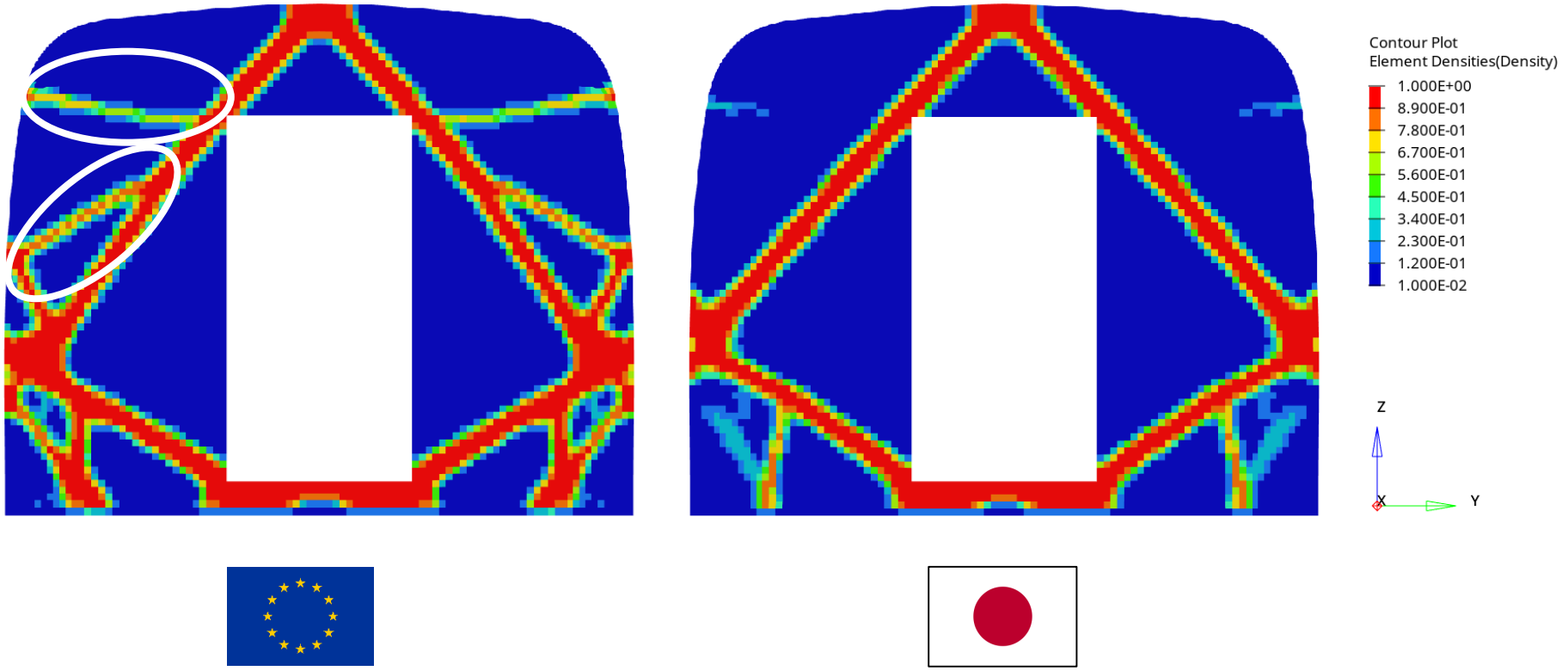
Lateral View



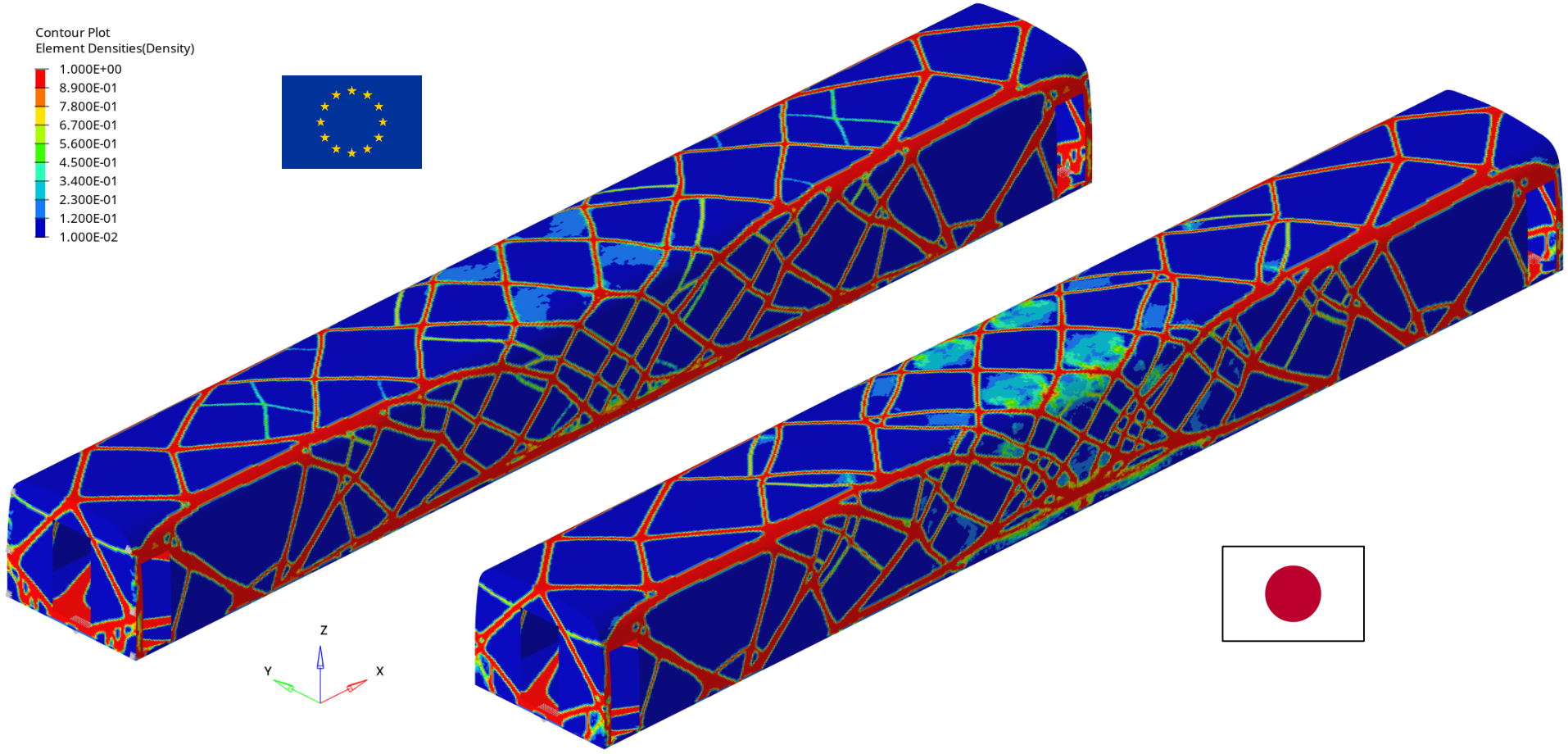
Bottom View



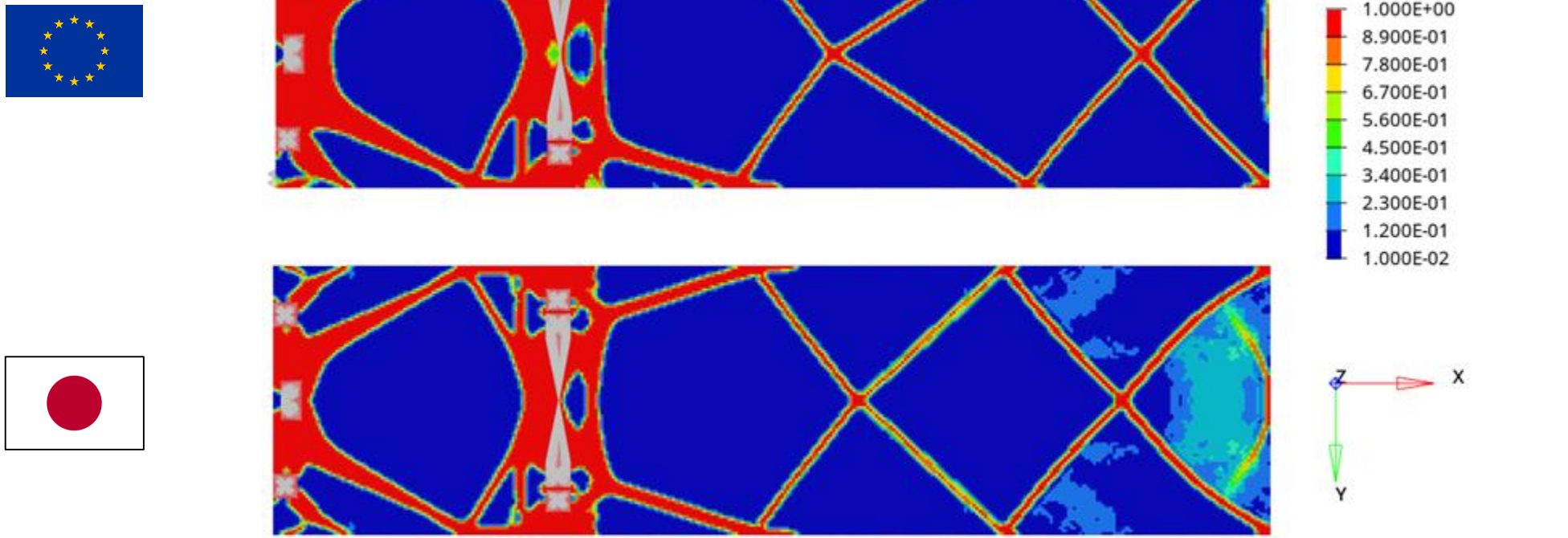
Bulkhead


Contour Plot
Element Densities(Density)
1.000E+00
8.900E-01
7.800E-01
6.700E-01
5.600E-01
4.500E-01
3.400E-01
2.300E-01
1.200E-01
1.000E-02
Z
X
Y

Topology Optimization Without Window Cut-Outs

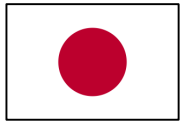


Floor


Contour Plot
Element Densities(Density)
1.000E+00
8.900E-01
7.800E-01
6.700E-01
5.600E-01
4.500E-01
3.400E-01
2.300E-01
1.200E-01
1.000E-02
Z
X
Y

Mass comparison

92%	With window cut-outs	92%
93%	Without window cut-outs	100%
52%	Without torsion	43%



Conclusion and Outlook

- Both JIS E 7106 and EN 12663-1 are based on the approach of static equivalent loads
- Longitudinal forces in Japan are significantly smaller than in Europe
- JIS E 7106 offers in some cases the opportunity for bilateral coordination of loads
- Topology optimization leads to similar and comparable results
- Can the specific results be generalized?
- Transforming the optimization results into a manufacturable design